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Making Fertilizer For Food Fuel & Fiber With Less Energy

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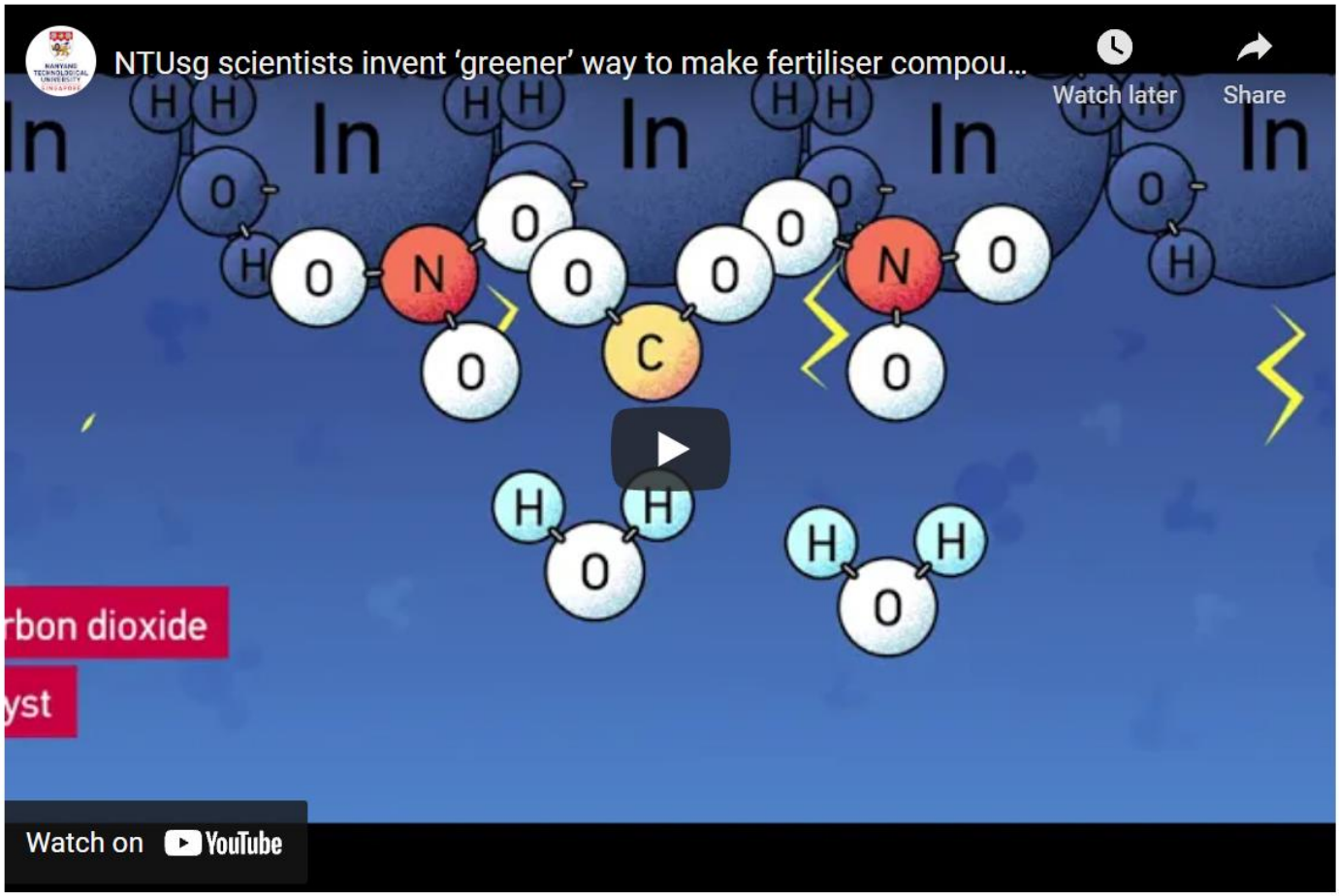
Nanyang Technological University researchers have devised a new less energy intensive method to make a key compound in nitrogen fertilizer, and that may pave the way to a more sustainable agricultural practice as global food demand rises.

The method devised by NTU researchers produces a compound known as 'urea', which is a natural product found in the urine of mammals, and an essential compound for fertilizers that is mass-produced industrially to increase crop yields.



However, the current Haber-Bosch process used to make urea is energy-intensive, requiring temperatures of 500° Celsius and pressures of two hundred times sea-level atmospheric pressure. It creates significant CO2 emissions, by using approximately 2% of global energy annually.

Seeking a more sustainable and energy efficient method, the team found a way to greatly improve an existing alternative approach to urea production known as electrocatalysis – using electricity to drive chemical reactions in a solution.

Using the nanomaterial indium hydroxide as a catalyst, the researchers reacted nitrate and carbon dioxide and found that the process formed urea five times more efficiently than previously reported attempts using electrocatalysis, specifically by causing the chemical reaction to take place in a 'highly selective' manner.

Co-lead author of the study, Professor Alex Yan from the NTU School of Materials Science and Engineering (MSE) said, "Our method essentially manipulates the chemical reaction process to become 'highly selective'. By picking a better catalyst, we helped the nitrate ions and carbon dioxide molecules to optimally position themselves to facilitate urea formation, while suppressing the creation of unnecessary by-products like hydrogen, leading to higher efficiency and better urea yields."

The study findings have been published in the journal Nature Sustainability, and the alternative urea production method has been patented by NTU.

This new method to produce urea may inspire the future design of sustainable chemistry approaches and contribute to 'greener' agricultural practices to feed the world's growing population, said the research team.

The study reflects the university's commitment to address humanity's grand challenges on sustainability as part of the NTU 2025 strategic plan, which seeks to accelerate the translation of research discoveries into innovations that mitigate our impact on the environment.